Effect of NPK Compound Fertilizer Normal and Nano on Some Growth Traits and Oil Content of Three Species of Apiaceae Plants

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Abstract

An experiment was conducted under the conditions of Al-Diwaniya governorate in a special nursery was specially constructed for the experiment during the autumn season (2016 - 2017) in order to determine the effect of adding the different levels of NPK fertilizer balanced (20-20-20) normal and nano to the soil of three species of Apiaceae (Cumin, anise and sweet fennel) and their interference in growth and oil content of seeds.

The factorial experiment that consist of two factor and with three replicates was designed by Randomized Completely Blocks Design (RCBD); the first factor consisted of three species of Apiaceae plant that above-mentioned, while second factor included seven levels of the NPK compound fertilizer balanced (control, normal NPK $^{\text{at recommended level}}$, nano NPK $^{\text{at recommended level}}$, normal NPK $^{\text{at double recommended level}}$, nano NPK $^{\text{at double recommended level}}$, Mixture NPK (Normal + Nano) $^{\text{at recommended level}}$, Mixture NPK (Normal + Nano) $^{\text{at double recommended level}}$). The means of the treatments was compared with a significant difference in the use of the least significant difference (LSD) at the probability level ($p \leq 0.05$). The results showed the superiority of sweet fennel plant in the following traits (plant height, total leaf area, dry weight of vegetative part) versus the superiority of the cumin plant in seed content of fixed oil, as well as anise plant was superiority in the number of branches per plant.

The significant effect of soil-additive fertilizers from normal and nano compound fertilizer in the increase of the majority of the studied traits and recording the highest mean in the NPK mixture at the double recommended or recommended level. The interference between factors gave the same significant effect to the superiority of the individual factors, as well as the improvement traits of more than double in some of them and the difference of response between plants depending on the type of fertilizer.

Keywords: NPK; nano; Apiaceae; growth; oil.

Introduction

Plants were grown that manufacture essential oils as medicinal materials, spices, perfumes and cosmetics; in temperate, Mediterranean and tropical climates, about 300 types of oils are important for the industry. They are used in therapeutics, Natural flavors and cosmetic perfumes. It is also known that there are 18000 plant species that manufacture essential oils and are described as producing plants. The annual production of volatile substances from plants that are mainly terpenoids is 1.4×10^9 tons [(1)]. For example, industrial turbines are produced from a few basic materials, while synthetic terpenes are capable of forming many terpenes complexes [(2, 3)]. A special advantage of monoterpene cyclase's is that many different products can affect the work of some, for example, Limonene synthesis produces small amounts of alpha, beta-penin and Myrcene [(1)].

Growth conditions largely determine the quantity and quality of raw materials. The method of planting, fertilization, irrigation and harvesting time for plant materials can significantly modify both the content and composition of active substances and essential oils. Bio-synthesis and other processes in the plant depend on a number of factors, most important of which are the presence of different input materials and enzymes depending on the metabolic pathway in which a particular group of compounds is formed [(4, 5)].

Nnutrition plays a major role in the growth and development of all crop plants. In the case of medicinal plants that synthesize essential oils, nutrients can effectively increase the yield and quality of the oil [(6 - 11)]. In the past few years, some researchers have tried to study the potential of nanotechnology to improve the efficiency of fertilizer use, these efforts have led to the design and development of nanomaterials. Nanotechnology-based fertilizers can be more soluble or more

[1] The research is a part of M.Sc. Thesis in the case of the second researcher

interactive than their larger counterparts [12 - 15]. Adding nanomaterials may improve solubility, distribution of insoluble nutrients (dispersion) on a large area of soil, reduction of nutrient mineralized (soil stabilization by nutrient saturation), increased bioavailability and the potential for easy absorption by plants and their long-term efficacy, soil and plant nutrients are nourished [14].

The aim of the study

The aim of the present study is to investigate the effect of the different levels of NPK compound fertilizer normal and nano, and the mixture between them in some of the growth and oil content of three species of Apiaceae (cumin, anise and sweet fennel) and determine the best level of fertilization according to the increase of the target traits in the plants with terms of comparison between increasing the qualities of growth at the expense of oil content or vice versa.

Materials and methods

1. Design and experimental procedure of the study:

Randomized Completely Blocks Design (RCBD) was adopted to a factorial experiment consisting of two factors and three replicates ($3^{\text{plant}} \times 7^{\text{NPK}} \times 3^{\text{replicates}}$). The first factor of three species of Apiaceae (cumin, anise and sweet fennel) while the second factor included seven levels of the NPK compound fertilizer balanced (control, normal NPK $^{\text{at recommended level}}$, nano NPK $^{\text{at recommended level}}$, normal NPK $^{\text{at double recommended level}}$, nano NPK $^{\text{at double recommended level}}$, Mixture NPK (Normal + Nano) $^{\text{at recommended level}}$, Mixture NPK (Normal + Nano) $^{\text{at double recommended level}}$), and three replicates for each treatment distributed randomly in block and became the total units experimental were 63 ($3 \times 7 \times 3 = 63$).

The experiment was conducted in the autumn season (2016 - 2017) corresponding to 15/11/2016, with the aim of knowing the effect of adding the different levels of NPK fertilizer (20-20-20) normal and nano to three species of Apiaceae (cumin, anise, and sweet fennel), and their interference in some growth traits and oil content of seeds. The seeds of the local plants were obtained from the approved agricultural offices in Al-Diwaniyah Governorate, while the normal compound fertilizers were produced by PRO-SOL Company by importing it by Dabbana Modern Agriculture Co. Ltd./ Baghdad, as well as pre-demand on Nano compound fertilizer from KHAZRA Co./ Iran.

The experiment was carried out by planting the seeds (5 seeds in each pot and was reduced after emergence to 4 only) for the plant species in pots (plastic pots) with dimensions (20 cm hieght × 15 cm width) and the capacity of 5 kg soil which filled it with mixture (1: 2) peatmoos and river's soil, and content it about 580 g. Kg^{-1} sand, 120 g. Kg^{-1} clay and 300 g. Kg^{-1} loam, with an average virtual density of 2.14 μg. M^{-3}, EC.= 7.6 ds. m^{-1}, sodium adsorption ratio (3.5 mmol. L^{-1}). According to the data below the experiment was executed:

a) Date of Agriculture 15/11/2016.
b) The date of the emergence of seedlings fully 25/11/2016.
c) The continues of irrigation process at a rate of (3) days between irrigation and other, in addition to the continuation of the cultivation and control operations throughout the period of cultivation.
d) The date of the first addition of the compound fertilizer by soil of both quality was done on 25/12/2016 according to the equivalent amount of the pot weight: 1 g. L^{-1}, (recommended) of normal compound fertilizer for each pot (5 kg soil) and 25 mg. 5 kg $soil^{-1}$ (recommended) of nano compound fertilizer.
e) Repeat the fertilizer additive of the plants according to the guidelines for each fertilizer until fruiting.

2- Studied characteristics:

a) Plant height (cm): Plant Height: by using measure tape the plant height was measured in each treatment, starting from the surface of the soil in the pot to the top of the plant, and then extracting the average from the ratio: Total of plants height/ plants number [16].
b) Branches number per plant (branch. $plant^{-1}$): By mean of a plant's branches in each treatment of the sum of dividing: Total branches number per plant/ plants number.
c) Total leaf area (cm^2. $plant^{-1}$): by using the Laser Portable Leaf Aria Meter the total leaf area of plant was measuring in each treatment by placing the whole plant leaves on the platform of the

device, after which the average was extracted from the sum of dividing: Total leaf area of plants/ Plants number.

d) Dry weight of plant vegetative part (g. plant^{-1}): The dry weight of the vegetative total of the plant was calculated in each treatment by random selection of two plants from each treatment, after they were removed from the soil, washed, cleaned from the residue of the suspended soil, then dried at room temperature and with fresh air flow until the weight was stable, and the mean was determined by dividing: Total plants weight/ plants number.

e) Fixed oil (%): The fixed oil was extracted by the cold press method during the exposing of plant seeds (2 g) to high pressure by a helical piston (Chinese origin) because it the characterized of speed and high quality of extracted oil [17].

3- Statistical analysis:

All data for the results under study were classified by the Microsoft Office Excel (2013) and Randomized Completely Block Design (RCBD) According to factorial experiment consisting of two factors (3 × 7) and three replicates. The results were statistically analyzed by using the analysis of variance in the Analysis ToolPak included in the scheduling program add-ins [18]. The means of the treatments were compared when the differences were significant by using the least significant difference test (LSD) at the probability level ($P \leq 0.05$), as indicated by [19].

Results

1- Plant height (cm):

The results in Table (1) showed the highest average plant height of 89.79 cm in the sweet fennel plant compared to the average height of cumin (61.23 cm) and anise (43.14 cm), respectively. The plant fertilizer at all levels under study showed a significant increase in plant height compared with control plants, as well as the recording of plants treated with double recommended of nano fertilizer average height of the plant height was significantly superior to all other averages due to the different levels of normal or nano compound fertilizer, which reached 73.11 cm. In the table, the recommended mixture of normal and nano compound fertilizer gave an average height of the plant higher than that of the double-recommended (71.06 and 69.78) cm, respectively.

Interference between plant species and compound fertilizer levels the highest elevation of cumin and sweet fennel was recorded when adding the double recommended of nano fertilizer (71.49 and 101.47 cm), respectively, compared with the average height of control plants (31.18 and 62.57 cm) respectively. While the highest of anise plant was 48.74 cm in the double recommended of compound fertilizer mixture compared with control plants (31.08 cm) and the plants treated with other fertilizer levels under study. However, the direct effect of the nano-fertilizer on the studied trait was the highest and the highest at the recommended level, or double recommended for study plants expect the combination of cumin at the recommended level of compound fertilizer.

Table 1: Effect of different levels of NPK compound fertilizer normal and nano on plant height average (cm), of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
cumin	31.18	58.56	59.26	68.18	71.49	70.39	69.59	61.23
anise	31.08	40.81	42.41	44.62	46.37	47.93	48.74	43.14
sweet fennel	62.57	84.02	95.45	99.16	101.47	94.85	91.02	89.79
average of compound fertilizer effect	41.61	61.13	65.71	70.65	73.11	71.06	69.78	
LSD $_{(P \leq 0.05)}$	Plant = 0.50			NPK = 0.77		Interaction = 1.34		

2- Branches number (branch. plant^{-1}):

Table (2) showed the positive effect of the study factors and their interaction in branches number of the plant. Anise plant recorded the highest number of branches with 7.85 branch. Plant^{-1} versus 6.95 branch. Plant^{-1} of cumin plant and 4.78 branch. Plant^{-1} of sweet fennel plant. As for the compound

fertilizer, its effect was positive at all levels compared with control plants, in addition to the moral superiority of the nano-compound fertilizer at both levels compared to normal compound fertilizers with the highest number of branches 8.10 branche. Plant^{-1} when the compound fertilizer mixture was treated at double recommended level compared to the other levels of compound fertilizer under study, and control plants (2.97 branch. plant^{-1}).

Interference between the plants and the levels of compound fertilizer gave a significant superiority of the study combinations compared with control plants. It also gave a significant superiority of the nano-fertilizer to its normal-fertilizer at each add level (recommended and double recommended) for the same plant expect sweet fennel at double recommended level of fertilizer, and the mixtures of compound fertilizer with a level of double recommended to cumin, anise and sweet fennel achieved the highest average number of branches (9.02, 8.96 and 6.32). Respectively, compared to all other combinations under study, including control plants, except the combination of anise plant with the compound fertilizer mixture at the recommended level, did not differ significantly in the effect of the number of branches with the same at the level of double recommended for the same fertilizer, Recording an average of 8.91 branch. Plant^{-1}.

Table 2: Effect of different levels of NPK compound fertilizer normal and nano on branches number average (branch. plant^{-1}), of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
Cumin	2.81	6.52	6.72	7.12	8.02	8.42	9.02	6.95
anise	4.61	7.52	7.72	8.52	8.72	8.91	8.96	7.85
Sweet fennel	1.50	4.31	4.61	5.31	5.41	6.02	6.32	4.78
average of compound fertilizer effect	2.97	6.12	6.35	6.98	7.38	7.78	8.10	
LSD $_{(P \leq 0.05)}$	Plant = 0.04			NPK = 0.07			Interaction = 0.12	

3- Total leaf area (cm^2. plant^{-1})

Table (3) showed that the sweet fennel plant was the largest leaf area (259.51 cm^2. plant^{-1}), 28% higher than cumin (188.55 cm^2. plant^{-1}) and 42% higher than anise (150.96 cm^2. Plant^{-1}). The average total leaf area of the plant at the levels of compound fertilizer was proportional to the increase in the level of fertilizer compared with control plants had lower average of trait, on the other hand, nano fertilizer at double recommended level (207.93 cm^2. Plant^{-1}) increased of total leaf area with 7% than the recommended level of the same fertilizer (193.91 cm^2. plant^{-1}) compared to the same effect between normal fertilizer levels, with an increase rate of about 12%, as shown in the table below.

Table 3: Effect of different levels of NPK compound fertilizer normal and nano on total leaf area average (cm^2. plant^{-1}), of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
Cumin	148.30	169.93	183.13	187.84	193.15	215.24	222.26	188.55
anise	123.02	128.98	146.23	152.75	165.31	168.67	171.75	150.96
Sweet fennel	213.21	224.38	252.36	256.42	265.32	298.43	306.46	259.51
average of compound fertilizer effect	161.51	174.43	193.91	199.00	207.93	227.45	233.49	
LSD $_{(P \leq 0.05)}$	Plant = 1.18			NPK = 1.81			Interaction = 3.13	

Significant interference showed the same effect of the individual factors. However, the significant superiority of the combinations was clear and positive in comparison within each plant, as well as between the plants. But, the combinations of the anise plant with the compound fertilizer mixture at the recommended and doubled it levels did not differ significantly between them, a recorded (168.67

and 171.75) cm ^{2}. Plant^{-1}, respectively, although the highest mean of the studied cultivar was recorded at the level of the double recommended of compound fertilizer mixture of sweet fennel, cumin and anise (306.46, 222.26 and 171.75) cm^{2}. Plant^{-1}, respectively.

4- Dry weight of plant vegetative part (g. plant^{-1}):

The data of table (4) showed that the average vegetative dry weight of the sweet fennel plant was significantly higher and more than five times higher than in the anise and cumin, respectively. It was 44.66 g at the sweet fennel compared with cumin (9.66 g) and anise (8.52 g), respectively. All the added levels of compound fertilizer gave a significant increase in the vegetative dry weight of the plant, achieved it top when the mixture treatment of double recommended level at 27.06 g compared to 9.44 g at the comparison plants, as well as the superiority of nano fertilizer treatment significantly on the normal increase in the target trait.

In the case of double interference, the combination of sweet fennel gave significant superiority on the other plant combinations as well as the relative increase in the proportion of fertilizer used and observed no significant differences within the anise plant combinations at the doubled levels of fertilizer, or between the recommended mixture and double recommended, the last recorded at the double recommended level was significantly superior on normal fertilizer, whereas the recommended combination of compound fertilizer (normal and nano) and the mixture of cumin plant did not show significant differences between them for the vegetative dry weight of the plant despite a slight increase with increase the level of added fertilizer, as the highest averages recorded to the trait under study at the double combination of compound fertilizer with sweet fennel plants, cumin and anise, which amounted to (57.05, 10.97 and 13.16) g, respectively.

Table 4: Effect of different levels of NPK compound fertilizer normal and nano on dry weight of plant vegetative part (g. plant^{-1}), of three species of Apiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
Cumin	2.79	8.68	8.78	10.27	11.87	12.07	13.16	9.66
anise	2.89	6.38	8.98	9.37	10.27	10.77	10.97	8.52
Sweet fennel	22.64	32.47	41.45	51.15	52.67	55.22	57.05	44.66
average of compound fertilizer effect	9.44	15.84	19.74	23.60	24.94	26.02	27.06	
LSD $_{(P \leq 0.05)}$	Plant = 0.42			NPK = 0.64		Interaction = 1.12		

5- Fixed oil (%):

The results indicated in table (5) showed that the highest content of the seeds of fixed oil was at cumin plant 10.62% compared to sweet fennel 3.58% and anise 3.79%, respectively, and a significant superiority between them. The effect of compound fertilizer at all levels under study showed a significant increase in the ratio of oil in the treated plants seeds compared to the comparison plants (5.05%). In addition, the plants treated with the double mixture of the compound fertilizer recorded the highest average content of the oil in the seeds (6.80%) and with a significant superiority over all other averages. It is also noted in the table that the nano compound fertilizer at both the recommended and double it has a mean average of the higher than normal compound fertilizer (recommended and double it) when it reached each of them (5.55 and 6.17) % for nano fertilizer and (5.42 and 5.79%) for normal fertilizer, respectively.

The interference between plants and compound fertilizer levels, the highest ratio of fixed oil was recorded for cumin plant combinations with different levels of fertilizer and significant difference between the combination and the other (except the compound fertilizer combinations at the recommended level, which did not differ significantly between them), up to the highest when the double mixture combination of compound fertilizer which reached 11.46%. While all anise combinations with both type of compound fertilizer and levels were significant superiority (except the compound fertilizer combinations at the recommended level, which were not significantly different) in the fixed oil ratio compared to the comparison plants (2.58%) except for the combination of normal compound fertilizer at the recommended level, 2.69% and did not differ significantly with the

comparison plants, and the highest ratio of fixed oil is 4.98% when the combination of double mixture of compound fertilizer. As for the sweet fennel plant, all its fertilizer combinations were significant superiority with plants seeds content of fixed oil on the comparison plants with 2.99%. However, when comparing the effect of the level of fertilizer, we note that there is no significant difference between the combinations of normal compound fertilizer with sweet fennel plant (3.39 and 3.51%), respectively, while the opposite was observed with the combinations of nano-compound fertilizer (recommended and double recommended) on sweet fennel with a significant difference between them and a mean of 3.47 and 3.83%, Respectively. The highest content of sweet fennel oil in seeds was 3.97% in the double mixture combination of compound fertilizer, which did not differ significantly with the lowest (3.90%), or the combination of nano compound fertilizer with double recommended level, as shown in the table.

Table 5: Effect of different levels of NPK compound fertilizer normal and nano on seeds content average of fixed oil (%), of three species of Aiaceae plants

Plants	NPK Compound fertilizer							average of plant effect
	control	recommended		double recommended		Mixture (normal + nano)		
		normal	nano	normal	nano	recommended	double recommended	
Cumin	9.57	10.17	10.37	10.67	10.91	11.17	11.46	10.62
anise	2.58	2.69	2.80	3.19	3.77	4.30	4.98	3.47
Sweet fennel	2.99	3.39	3.47	3.51	3.83	3.90	3.97	3.58
average of compound fertilizer effect	5.05	5.42	5.55	5.79	6.17	6.46	6.80	
LSD $_{(P \leq 0.05)}$	Plant = 0.08			NPK = 0.12			Interaction = 0.21	

Discussion

The care of medicinal and aromatic plants is due to the fact that it is the first major source of access to medicines since the beginning of creation. Human beings used plants in their food, to relieve their pain and treat their various diseases by using one or all parts of the plant after soaking, boiling, or making of mask form without confirming it and searching for the substance containing it, which causes the therapeutic act or part of the plant of therapeutic interest, but depending on the experiment only, and with the progress of science and technology, scientists and researchers have been able to separate the active substances from the plants containing them and to prepare them in a way that suits their use and the pathological condition for which they are used. When talking about medicinal and aromatic plants, their importance, their cultivation and their service after planting, the following processes of collection and processing and knowledge of the different methods of increasing and extracting active substances, during stimulation with external or internal factors, including the increased chemical content of the plant and its close relationship with medical and food industries [20 - 24].

The increase in the vegetative growth characteristics of cumin, anise and sweet fennel was significant for NPK normal or nano; or NKF fertilizer mixture compared to non-addition (Tables 1-5). This positive effect may be due to the important physiological role of nitrogen in the molecular structure of the physical molecules such as porphyrin in important metabolic compounds such as chlorophyll pigments and cytochrome, which are essential in photosynthesis and respiration as well as coenzymes that are activated by phosphorus and are necessary for the function of many enzymes and produced amino acids used in protein synthesis [25]. As well as potassium responsible for enzymatic activity and protein structure stability [26]. Accordingly, nitrogen plays an important role in the synthesis of plant components along with phosphorus and potassium by activating the work of various enzymes and the synthesis of proteins [27], which is reflected in the increase on the growth indicators of plants such as cumin, anise and sweet fennel, these results are consistent with those obtained by Hellal *et al*. [28] on dill (*Anethum graveolens* L.); Khalid and Shedeed [29] on black seed (*Nigella sativa* L.); Abdollahi *et al*. [30] on coriander (*Coriandrum sativum* L.), all of which reported that nitrogen fertilizer treatments were superior significant on the treatment of control and significantly improved the characteristics of vegetative growth of apiaceae plants.

Since all levels of NPK added to the soil gradually increased from the fixed oil (%) extracted from the seeds of cumin, anise and sweet fennel, which recorded the highest content with the compound

fertilizer mixture of these plants compared with control plants, and that the final level of compound fertilizer (The mixture at the multiplier level) is optimal in obtaining the highest concentration of aromatic oil than in the comparison treatment and other treatments, which may be due to the nitrogen effect of the compound fertilizer on enzymatic activity and metabolism for the production of essential oils as in the results of Khalid [31] on some Apiaceae plants; Hellal *et al*. [28] on dill; Abdollahi *et al*. [30] on coriander; and they who agreed in their results on the positive effect of nitrogen fertilizer in the amount of aromatic oil extract Apiaceae plants.

Conclusion

The significant effect of additive fertilizer levels from balanced NPK compound fertilizer (20-20-20), normal or nano increase all growth traits and oil content are directly related with increasing the level of fertilizer, which achieved significant superiority to nanofertilizer compared with normal fertilizers, while showed the mixture fertilizer were highest superior of its' kind compared to a single fertilizer (nano or normal).

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Dear Author(s)

Dr./Mr. Dhafir A. Jameel / AL-Qadisiyah University, Iraq Dr./Mr. Arkan Ali S. Al-Tai / AL-Qadisiyah University, Iraq

Greetings, with reference (JPT 26) to your article entitled:

Effect of NPK Compound Fertilizer Normal and Nano on Some Growth Traits and Oil Content of Three Species of Apiaceae Plants

We wish to bring to your kind notice the following

√ **We acknowledge the receipt of the above mentioned article.**
√ **The above mentioned article(s) has been sent to the reviewer of expert comments**

√ **The above mentioned article(s) have been accepted for publication in the (Research Journal of Pharmacy and Technology).** The probable date of publication is**; Vol:10 (No:11-12): 28 December-:2017**

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